Ohio Agricultural Experiment Station

CIRCULAR No. 128

WOOSTER, OHIO, JUNE 24, 1912

FEEDING DAIRY COWS

Nature's balanced ration.

CONTENTS

FEEDING DAIRY COWS

BY C. C. HAYDEN

INTRODUCTION

In the production of milk there are four factors which are of prime economic importance.

1. Cows must be secured which are capable of producing large quantities of milk and butterfat.
2. These cows must be properly housed and cared for.
3. There must be a feeder who has keen eyes and good judgment.
4. Sufficient food of the proper quality must be supplied.

The best way to obtain good cows is by the careful selection and breeding of animals from one of the recognized dairy breeds or their grades. "Scrub" cows have no place in profitable milk production. On the other hand, no matter how carefully cows are selected nor how well bred, if poorly fed, they will give little better returns than "scrubs."

To become a good feeder requires a knowledge of the needs of the dairy cow and of the nature of different feeds. *This means that the man, who is to become a successful feeder, must be willing to spend time and energy in studying the details of these subjects.*

The cow is a business partner not easily defrauded, and if she is the right kind of a cow, supplied with the right kinds and amounts of feed she will do her share in the partnership. If the proper feeds are wanting, she will withhold the desired product. Food of the right kind and amount is necessary to any considerable degree of production.

The question most commonly asked is, "What is the best feed for dairy cows?" This question may seem simple and easy to answer, but it is really quite difficult. *No definite short rule can be given which will serve as a guide under all conditions, nor can a ration be given which will apply in all cases.* Therefore, the best we can do is to put into the hands of the feeder the methods whereby he can work out these problems for himself, and the sooner he realizes this fact the better it will be for his bank account. (The proper use of the head saves both muscle and money.)

THINGS TO CONSIDER

There are many things which should influence the feeder in selecting feeds and working out a balanced ration for his herd. Some of these are given below:

1. The composition of feeds as shown by chemical analysis. Do they contain the materials necessary to support the animal and make milk?
2. The feeds which can and should be grown on the farm.
3. The feeds which may be purchased and their relative value.
4. The quality and condition of the feeds to be used.
5. Their physiological effect on the animal.

The above factors will be discussed separately and as plainly as possible.

COMPOSITION OF FEEDS

Chemical analysis shows that all of our common feeds contain all of the different materials needed in the production of milk, but in most cases they are not in the proper proportions for the best results. While the necessary materials are there, they vary widely in the amounts present, as shown by the tables on pages 206 to 211. From the farmer's standpoint, only three of these food materials need be considered, because the others are present in sufficient amounts. These three materials (called nutrients) are **protein, carbohydrate** and **fat**, which go to build up and maintain the body. A chemical analysis of milk shows that it contains these same nutrients in different forms. The protein in the feeds is represented by the curd and albumen in the milk, and the carbohydrate and fats by the milk sugar and the butterfat. Therefore, the nutrients go to make milk as well as to maintain the animal body.

Protein is a compound containing nitrogen, which is so costly in feeds and fertilizers and which can be secured from the air by clover, alfalfa, cowpeas and other legumes. In the animal body protein is used to form muscle, blood, connective tissue, tendon, etc., as well as curd or casein and albumen in the milk. Neither carbohydrate nor fat can be used for this purpose, because they do not contain nitrogen. Protein forms nearly one-third of the solid material found in milk; therefore, it must be supplied in rather large quantities. Most of our common feeds do not contain a sufficient amount; therefore, we purcnase such feeds as linseed meal, gluten feed, cotton-seed meal, bran, and other feeds rich in protein. Protein should make up about one-sixth of the nutrients in the ration of a good cow when in milk, or one pound of protein to about six pounds of the carbohydrate and fat. It is important to remember that no

other food material can take its place, and that it is absolutely necessary to maintain the animal and produce milk. It is usually the most expensive part of the ration and, therefore, should not be fed in larger quantities than needed.

Carbohydrate of feeds is a nutrient which differs from protein in that it does not contain nitrogen, and that it is abundant in our common grains. It is found in the form of starch, sugar, fiber, etc., and is used by the cow to supply energy, heat and fat in the body, and sugar and fat in the milk. It is the cheapest nutrient in our feeds, because it is most abundant, and it is used in larger quantities by the cow than protein and fat.

Fat, or oil, is the third nutrient in feeds, which it is necessary to consider. It is contained in all feeds, but the quantity varies widely and it is never in as large quantities as the carbohydrate. It is used by the cow for the same purposes as the carbohydrate and contains the same elements but is more concentrated. Careful experiments show that, in feeding, one pound of fat will take the place of two and one-fourth pounds of carbohydrate; therefore, in making up rations, we consider it worth two and one-fourth times as much as an equal amount of the carbohydrate.

Since these last two nutrients (carbohydrate and fat) contain the same elements and answer the same purpose in feeds, *hereafter, they will be considered together. The fat will be multiplied by two and one-fourth and added to the carbohydrate, and it will be spoken of as the carbohydrate and fat.*

In the table which shows digestible nutrients in our common feeds, the protein is given in the first column, the carbohydrate and fat in the second column, and the nutritive ratio in the third column. Remember that the nutritive ratio is the relation in quantity of the digestible protein to the digestible carbohydrate and fat. In other words, a nutritive ratio of 1 to 6, means one pound of protein to six pounds of carbohydrate and fat. The table mentioned above will be found on page 206.

FEEDS GROWN ON THE FARM

What feeds can and should be grown on the farm is a question of first importance to the dairyman. It is time that all dairymen begin to farm to feed dairy cows instead of feeding dairy cows simply to dispose of their crops. Feeds grown on the farm are essentially the cheapest, if they can be successfully grown, because all feeds must be grown on some farm, and to feeds purchased must be added the expense of preparation and transportation. In making the above statement it is recognized that home grown feeds can not

always be depended upon alone, and that it becomes necessary to purchase feeds to fill out or supply protein which may not be sufficient in the home grown feeds. It is also true that some crops can be grown well on our farms, which are not suited for feeding to dairy cows and which would be expensive if used for that purpose. These should be sold and other feeds purchased.

The best crops to grow for feed on the dairy farms of Ohio are the following: of the grains, corn, oats, rye and possibly soybean; of the roughages, corn stover, the clovers, alfalfa, cowpeas, soybean, field peas and oats, millet and sorghum; of the succulent feeds, silage, mangel, and sugar beet. There may be other crops which would be advisable under special conditions. If dairying is the chief business on the farm, and if profit is the aim, it is very important that every crop should be planned years ahead; and substitute crops should be planned to take the place of any crop which may fail. The lack of space forbids the discussion of the proper rotation of crops for dairy farms.

GRAINS

Corn.—This is the most important crop for Ohio dairymen. It can be grown successfully in all parts of the State and it furnishes the largest amount of food nutrients per acre. For these reasons, it is the cheapest food, in so far as it can be used. Because of the fact that it carries less protein than required for a balanced ration, it can not be fed alone with economy. If of good quality, it is always relished by cows, and it can be fed in a variety of forms; from the field while green as a soiling crop, from the shock as fodder corn (stalks with ears), the ground grain and the stalks, or in the form of silage. The dairyman who can find a complementary crop or crops which he can grow successfully, and which contains enough protein to balance the ration with corn, has the problem of economic feeding quite well in hand.

Oats.—This crop can be grown well, especially in the central and northern parts of the State. It is an excellent feed for dairy cows and contains more protein than does corn. In fact, the grain, if fed alone, would make practically a balanced ration from the standpoint of protein and carbohydrates. The yields of nutrients per acre are so much less than in corn that it is usually rather an expensive feed. A bushel of corn contains more than twice as many pounds of digestible nutrients as a bushel of oats. Therefore, the land which will produce 50 bushels of corn should produce over 100 bushels of oats, if the same amounts of digestible nutrients are obtained. When corn sells for 70 cents per bushel, oats is worth 35

cents and corn is worth per ton about one-fourth more than oats. Outside of this question of cost, oats is an excellent feed for dairy cows and especially for growing calves.

Barley.—Where barley can be grown well, it makes a good feed. In composition it is much the same as corn except that it contains a lower percentage of nutrients and is not as valuable bushel for bushel; therefore, it should not be grown generally, unless the yield is much better than that of corn, or unless desired in a rotation. It contains very little more protein and should take about the same place in rations. Barley contains about one-eight less digestible nutrients per ton than corn.

Wheat.—This grain is not commonly used for feeding cattle because of the great money value. When used, it should take the same place in the ration as corn. It carries a little higher percentage of protein.

Soybean.—This bean may become a profitable crop for dairymen in the future. It does not yield as heavily per acre as the feeds mentioned above; but it contains a high percentage of protein and can be fed safely in quantities not greater than three pounds per cow per day. If used in larger quantities, it may taint the milk. It will not be advisable to grow the soybean for the grain, unless the cost of production is less per ton than the cost per ton of linseed meal. It can be used to replace linseed meal, cotton-seed meal, bran, etc., in rations.

ROUGHAGE

Stover and Fodder Corn.—Besides supplying the cheapest grain, corn also supplies a large amount of roughage in the form of corn stover (stalks without ears). When properly cured it can be used to good advantage, though it is not so valuable as some of the other roughages. When fed as fodder corn (with the ears) a large amount of roughage is supplied. This may be done to good advantage under certain conditions, but it is not to be recommended generally. When so fed, it should be planted thickly so that only small ears develop. In most cases it is better to grind the grain and feed it separated from the stalks. In the form of silage, which is discussed on page 190 corn furnishes a good deal of roughage. In whatever form used the corn plant lacks protein.

Clovers.—The common red clover makes one of the best roughage crops for our dairy farms. It can be grown in all parts of the State, but not to the best advantage on all soils. It is desirable because it contains a fairly high percentage of protein which will help to balance the ration, and it also collects nitrogen from the air. Red

clover is not quite as sure as some other crops, but a failure is evident early enough in the spring to permit the sowing of a substitute crop, such as cowpeas, soybeans, or peas and oats. Clover is always relished by cows if it is cut early enough and properly cured. For the best results clover should be cut before too ripe, or when in full bloom. It contains a high percentage of crude fiber, which is the least digestible part and which increases very rapidly as it ripens. Clover yields well and is not very difficult to cure. The second crop, if clean and well cured, is as good as the first. Clover can be made into silage but is difficult to handle in the field, and generally it is better to use it as hay with corn silage.

Alsike clover contains a higher percentage of protein and, for this reason, is possibly of more value per ton; but as a rule it does not yield as well as the medium and mammoth red clovers.

Alfalfa.—Where alfalfa can be successfully grown, it is probably the best roughage or hay crop. It yields well, even rivaling corn in the amount of digestible nutrients produced per acre. Besides this fact, it contains a high percentage of protein, for which reason it is especially adapted to feeding with corn, which is lacking in protein. With good well-cured alfalfa hay, it is possible to supply the protein needed for fairly heavy production of milk. Alfalfa can be grown successfully in many parts of Ohio and on a variety of soils. For two years, the Illinois Station fed a small herd of dairy cows on corn silage and alfalfa hay with a very little corn meal to the heaviest milkers, and the cows produced an average of 8,500 pounds of milk per year. These, however, were large cows, capable of handling a large amount of roughage.

Cowpea.—This crop grows well in the southern part of the State and can also be grown in the northern part, though it requires a fairly long season to mature. It is here discussed as a hay crop, and not as a grain crop. Like clover and alfalfa, it requires some care in curing. It should be cut, wilted, and placed in small cocks, where it should remain until dry. These cocks turn water well, and though the outside turns dark, the inside of the cock will remain green. A variety should be used which produces a large amount of vine rather than many peas. The proper time to cut it is when the first pods begin to ripen. It is more easily cured for hay than the soybean, because it produces less fleshy pods and does not drop its leaves so easily. The stems are much less woody than those of the soybean. Cowpea hay is eaten readily by cattle, though not quite so palatable as alfalfa, and is almost as good ton for ton as that made from alfalfa, since it contains only about one percent less protein. The yields per acre are not so large as of alfalfa, but are usually

equal to the clovers. Probably the greatest drawback is the cost of and difficulty of procuring the seed. If in the early spring it is evident that the clover crop has frozen out or is a failure, the land can be sown to cowpeas. It can be grown on land which is not well adapted to clover or alfalfa.

Cowpea Straw.—Cowpea straw consists of the stems and leaves after the peas have been removed. It is fed by many farmers and makes a very good roughage, though not as valuable as the hay. In order to get the pea properly ripened the stalks become too ripe for the best hay; many of the leaves are lost and the stems become more woody. It is much lower in protein than the hay, probably standing near clover hay in this respect, and it is also less palatable.

The cowpea should be sowed at the rate of one and one-half bushel per acre in the spring as soon as the ground is warm or soon after corn is planted. It will, perhaps, stand up better and cure a little more readily if a little millet is sowed with it. This, however, reduces the quality of the hay from the standpoint of protein, which must be considered in balancing the ration.

Soy Beans.—See Bulletin 237.

Canada Field Pea and Oats.—These can be grown to advantage by many of our dairymen. They yield well, are palatable and contain a fair amount of protein. They are excellent crops for early soiling and can be made into hay which is superior to timothy or millet for dairy cattle. Like the cowpea, they can be used as a substitute for clover when that crop fails. They are a little difficult to cure as hay, because of the large amount of water contained, and should be cut for this purpose when the oats is in head, but before it is ripe.

Millet.—When earlier crops fail, or as a second crop following some earlier crop, millet can often be used to good advantage. It does well late in the season, is easily grown, and yields well; but it is not very palatable and contains a small amount of protein. In this respect it is similar to corn or sorghum.

Sorghum.—There are several varieties of sorghum, and where it can be grown well it makes a good roughage. It is sown thickly and cut and cured as hay. If not sown thickly, it becomes coarse with a hard, woody covering to the stem. It is delicate when small and slow in starting, but grows rapidly later and yields well. It is sometimes used as silage, but this is not advisable where corn can be grown well. Sorghum is also low in protein and must be fed with concentrates high in protein. It should be cut after the heads are well formed but before ripe. Sometimes stunted sorghum or the second growth is fatal to cattle; hence it should be fed with care.

Timothy.—Timothy hay is a very poor roughage for dairy cows, and should be used only when legume hay can not be had. No dairyman should produce timothy hay for this purpose.

SUCCULENT FEEDS

Succulent feeds are those feeds which contain a large percentage of water and are fed green or to take the place of green feeds. Such feeds tend to keep the bowels of the animal loose, which is natural in cattle; therefore, they are valuable for feeding with dry feeds during the winter season.

Silage.—Because of its ease of production, handling and preserving, silage is the most important feed of this class. It may be made from corn, sorghum, clover, alfalfa, cowpeas, etc., but corn is by far the best crop for this purpose. There have been many complaints and objections to its use in the past, but these are rapidly disappearing. The condensing companies which have been opposed to it are now permitting and even encouraging its use. Most of the other complaints come from places where it is used for the first time. This is usually due to cutting the corn too green or to improper filling of the silo. Too green corn makes a sour silage, which, if fed in too large quantities, causes indigestion and scours. Beginners often are dissatisfied because they have expected too much from the use of silage. It must be remembered that it is not a balanced ration and can not be used alone; nor should it be used with grain only, but with a liberal allowance of some dry roughage. Ordinarily not more than 30 to 40 pounds should be fed regularly to each cow daily unless she is a very large cow.

In making choice silage, it is essential that the corn mature far enough for the grains to become dented and many of the husks to begin turning dry. When the large "silage corn" is used it should be planted early and allowed to mature as far as possible without too great danger of frost. It is yery important that it be well distributed and thoroughly packed in the silo. Pea vines and sweet corn refuse from canning factories can be used in the silo to good advantage.

Frozen silage is not harmful to cows unless fed too freely while still frozen, or allowed to spoil after thawing before being fed.

Mangel.—This crop is used in certain localities and is very good feed. It can be grown with less labor than other root crops and the yields are good, but it is not as rich in nutrients as some other roots. Where root crops are used for winter feeding it is almost necessary to have a root cellar. They can well take the place of silage in the ration. The greatest objection to mangels and all root crops is the great cost of labor in their production.

Sugar Beet.—This makes an excellent dairy feed and is highly prized by some breeders for feeding when making official records. There is a belief on the part of some persons that it temporarily increases the percent of fat in the milk. Where the soil is adapted to the growth of sugar beets they yield well.*

The above are the three succulent feeds which can be depended on in Ohio and silage is by far the best of these, mainly because of the lower cost of production and ease of handling.

PURCHASED FEEDS

What feeds should be purchased to feed with those grown on the farm? This opens a question which can not be discussed fully. Speaking generally, only those feeds should be purchased which will supply the protein lacking in the feeds grown on the farm. Where a sufficient amount of feed can not be grown it often becomes necessary to purchase other feeds than those needed for protein.

There is a long list of mixed feeds on the market and it becomes quite a problem for the farmer to decide which he should select. For a number of these extravagant claims are made by agents, either willfully or ignorantly. Dairymen should remember that there is nothing better than the straight grains and their by-products (bran, shorts, middlings, linseed meal, cotton-seed meal, brewers' grains, gluten feed, etc.,) when properly combined with home-grown roughage in the ration. So many of the new mixed feeds now on the market have not been tried out in feeding tests, and it is so easy for the manufacturer or mixer to vary the contents, that it is difficult to state their value in terms of available nutrients, which is the true measure of value. For these reasons, they are not given in the table. Given percentages of nutrients are guaranteed but these are *total and not digestible nutrients.* Their digestibility and value depend much upon the materials from which they come. Many of these mixed feeds contain mill screenings with weed seeds, oat hulls, chaff, etc., which are of little if any value. They are usually claimed to be balanced rations in themselves. *The dairyman who has his own farm should not purchase a balanced ration*, but something which when added to his homegrown feeds will give a balanced ration; and this will almost invariably be a feed which contains a high percentage of protein, and the problem will be to determine which feed will give the cheapest protein. Table 1 has been compiled to assist in the selection of such feeds. In practically all parts of Ohio corn will furnish the cheapest digestible nutrients, exclusive of the protein needed for balancing the ration. Therefore, corn, or ground corn is used as the basis of comparison in the table and should be used as far as possible in the ration.

*See Bulletin 50 of this Station for comparison of beets with silage in feeding for milk.

TABLE 1. RELATIVE VALUE PER TON OF GRAINS AND SILAGE LESS PROTEIN ABOVE CORN

Dent corn per bushel	$ .40	$ .42	$ .45	$ .48	$ .50	$ .53	$ .56	$ .59	$ .61	$ .64	$ .67	$ .70	$ .73	$ .76	$ .79	$ .82	$ .85	Protein
Dent corn per ton	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23 00	24.00	25.00	26.00	27.00	28 00	29.00	30.00	
Corn and cob meal	11.77	12.61	13.44	14.27	15.12	15.95	16.79	17.62	18.46	19.31	20.15	20.98	21.82	22.66	23.49	24 33	25.16	—36
Corn meal	13.08	14.01	14.94	15.87	16.80	17.73	18.66	19.59	20.52	21.45	22 39	23.31	24.24	25.17	26.10	27.03	27.96	—26
Hominy Feed	13.83	14.81	15.79	16.78	17.17	18.74	19.72	20.70	21.69	22.67	23.66	24.64	25.62	26 60	27 59	28 47	29 45	—20
Gluten Feed	10.85	11.62	12.39	13.16	13.93	14.70	15.47	16.25	17.02	17.79	18.56	19.33	20.10	20.87	21.64	22.41	23.19	+305
Oats per ton	10.75	11.51	12.27	13.04	13.81	14.57	15.34	16.10	16.86	17.63	18.39	19.16	19.92	20.68	21.45	22.22	22.98	+95
Wheat bran	8.71	9.33	9.94	10.56	11.18	11 89	12.42	13.04	13.65	14 28	14.90	15.51	16.13	16.75	17.37	18.00	18.60	+141
Wheat Middlings	11.49	12.30	13.12	13.94	14.75	15.57	16.39	17.20	18.02	18 84	19.65	20.47	21.30	22.10	22.92	23.74	24.55	+210
Wheat Shorts	10.21	10.93	11.66	12.39	13.11	13.84	14.56	15.29	16 01	16.74	17.47	18.19	18.92	19.64	20.37	21 09	21.82	+146
Barley per ton	12.62	13.52	14.42	15 32	16.22	17.11	18.01	18.91	19.81	20.70	21.60	22.50	23.39	24.29	25.19	26.08	26.98	+28
Wet brewers' grains	2.08	2.23	2.38	2.53	2.68	2.83	2.97	3.12	3.27	3.42	3.56	3.71	3.86	4.01	4.16	4.34	4.56	+75
Dry brewers' grains	8.36	8.95	9 55	10.14	10.73	11.33	11.92	12.52	13.11	13 71	14.30	14.89	15.49	16 08	16.68	17.27	17.86	+307
Malt sprouts	9.51	10.19	10.86	11.54	12.22	12.89	13.57	14.24	14.92	15.60	16.27	16.95	17.63	18.30	18.98	19.65	20.32	+302
Dry distillers grains	12.03	12.90	13.75	14.60	15.46	16.31	17.17	18.02	18.88	19.73	20.59	21.45	22.30	23.16	24.01	24.87	25.72	+322
Rye	13.19	14.13	15.06	16.00	16.94	17.88	18.81	19.75	20.68	21.63	22.56	23.50	24.44	25.38	26.31	27.25	28.19	+43
O. P. linseed meal	8.69	9.30	9.92	10.53	11.15	11.78	12 38	13.00	13 62	14 24	14.86	15.47	16.09	16.71	17.33	17.94	18.56	+507
N. P. linseed meal	7.51	8.05	8 59	9.12	9.66	10.19	10.73	11.26	11 80	12.33	12.86	13.40	13.93	14.47	15.00	15.54	16.07	+546
Cotton-seed meal	7.87	8 43	8.98	9.55	10.10	10.66	11.22	11.78	12.34	12.90	13.46	14.03	14.58	15.14	15.70	16.26	16.82	+610
Soybean meal	10.25	10.98	11.71	12.44	13.17	13.90	14.63	15.36	16 09	16.82	17.55	18.28	19.02	19.75	20.47	21.20	21 93	+468
Corn Silage	2.89	3.08	3.27	3.46	3.65	3.84	4.03	4.22	4.41	4.60	4.79	4.98	5.17	5.36	5.55	5.74	5.93	—4

— indicates less protein than in corn. + indicates more protein than in corn.

It is assumed that the same quantity of digestible protein, carbohydrate and fat are of no more value in any other feed than they are in corn. This is approximately true. If the carbohydrate and fat in a ton of any feed are taken and enough of the protein added to them to give the same percent of protein contained in corn, these nutrients would be worth the same price per pound as the nutrients in ground corn. Whatever the feed costs per ton above this amount must be charged against the remaining or surplus protein. Example: There are 1,686 digestible nutrients in a ton of dent corn (9.25 percent protein) and, if corn is worth $20 per ton, each pound of nutrients is worth 1.18 cts. O. P. Linseed meal contains 1,047 pounds of nutrients containing 9.25 percent protein and in addition to this 507 pounds of protein (surplus protein). The 1,047 pounds at 1.18 cts. per pound equals $12.35. If linseed meal costs $30 per ton, the cost of the 507 pounds of surplus protein would be the difference between $12.35 and $30, or $17.65. The $17.65 equals the cost of the 507 pounds of protein, or 3.5 cts. per pound. The relative values of the feeds given in the table were worked out on this basis. Other things being equal, the feed supplying the surplus protein at the lowest cost per pound should be selected. The effect of the feeds on the cow and the milk should be considered.

HOW TO USE THE TABLE

If wheat bran and cotton-seed meal are to be compared, proceed as follows: Find the local price of corn in the upper line, say 56 cents per bushel, or $20 per ton. Farther down the same column, on the line headed "wheat bran" are the figures $12.42, which is the value of the nutrients in a ton of bran minus the 141 pounds of surplus protein shown in the last column to the right. Subtract the $12.42 from the local price of bran, say $25 per ton, and the result is $12.58 which is the cost of the 141 pounds of the surplus protein. Divide the $12.58 by 141 and the result shows that the cost of the protein is 9 cents per pound. Farther down the same column, on the line headed "cotton-seed meal," are the figures $11.22, which is the value of the ton of cotton-seed meal minus the surplus protein. Subtract this $11.22 from the local price of cotton-seed meal, say $35 per ton, and the result is $23.78, or the cost of 610 pounds of surplus protein. $23.78 divided by 610 equals 3.9 cents per pound. At these prices the protein in the cotton-seed meal would cost less than one-half as much as in wheat bran. Example:

Local price per ton		Value of Nutrients less surplus pro.		Cost of surplus pro.		Pounds surplus pro.		Cost per lb. surplus pro.
Corn.....$20.00	—	$20.00	=	$ 0.00	÷	000	=	$0.000
Bran..... 25.00	—	12.49	=	12.51	÷	141	=	0.088
Cotton-s. m 35 00	—	11.22	=	23.78	÷	610	=	0.039
						Difference		$0.049

In this case, other things being equal, the cotton-seed meal should be purchased.

Because of the necessity of introducing another variable factor, the fertilizing value of the feeds has not been considered in the above table.

THE QUALITY OF FEEDS

The quality or condition of the feeds to be used is a question of no little importance, because feeds of the best quality always give the best returns at the milk pail. Great care should be taken to harvest and cure all home grown feeds in the best possible condition. This guarantees the least loss of nutritive value and also preserves the palatability, or relish, which can not be ignored in feeding. The cow will eat more of and digest better, that which she likes best. Musty or moldy feeds are apt to cause digestive disorders, because they carry large numbers of bacteria and molds; and such feeds are objectionable also because they may cause the milk to become contaminated with bacteria or odors.

EFFECT OF FEEDS ON THE MILK

There is a general belief that the composition of milk can be changed by the use of different feeds. This is true to only a very limited extent. The quality of the milk is determined by the breed or individuality of the cow. If a cow is fed a reasonable amount of a balanced ration, the kind of feed will have very little effect on the percent of fat, or other solids in the milk. Any very sudden and radical change in the ration may produce a temporary change due to the effect on the system of the cow. This change soon returns to normal.

The flavor of milk may be materially affected by different feeds. Any sudden and radical change may affect the flavor, at least, temporarily. Silage, if fed before or during milking, gives the milk a "silage flavor." Objectionable flavors come from certain weeds, rape, cabbage, turnips, wild onions in pasture, bad silage, etc. The most common objectionable flavors come from filth on the cows and about the barn, which gets into the milk and carries with it the bacteria which cause these flavors.

EFFECT OF FEEDS ON THE ANIMAL

In selecting feeds, the effect which the feeds may have on the animal should be kept in mind. It is well known by dairymen, that certain feeds have a laxative effect and that others have a costive effect on the bowels. It is natural for the droppings from a cow to be soft and not hard like those of the horse. Such feeds as oil meal, silage, alfalfa hay, cowpea hay, brewers' grains, and roots have this laxative effect and are called good conditioners. They are complementary to those which are not good conditioners; as corn, cotton-seed meal, clover (late cut), millet, corn stover, straw, etc. In compounding rations, care should be taken to get the best combinations; that is, some good conditioners along with the others. Cotton-seed meal, clover hay and corn meal do not go together as well as cotton-seed meal, corn meal, silage and clover hay. When corn and clover hay are used, the linseed meal will answer better. Corn meal alone is said to be too heavy and not readily mixed with the digestive juices. This is probably true to only a limited extent, but this can be overcome by feeding the grain with silage or mixed with other cut roughage. Much depends on keeping the system of the cow in good working order.

HOW TO BALANCE A RATION

A ration is the feed given an animal daily. A balanced ration is one containing just the amount of digestible protein with carbohydrate and fat needed by the animal which is to receive it. The needs of different animals differ and the needs of the same animal vary from time to time. A ration balanced for a cow giving a large amount of milk would not be balanced for a cow giving a small amount of milk nor for a dry cow.

The cow requires a certain amount of feed to supply the needs of the body when she is doing no work; this we call the food of maintenance. Above the food of maintenance she requires feed according to the work she is doing. The work consists in adding fat to the body, growing a calf, making milk or all of these three. If a cow stands in a stall and makes milk she works just as truly as the horse which pulls the plow. For maintenance, or to keep up the life activities of the body, enough feed is required daily to supply .07 pound of protein and .72 pound of carbohydrate and fat for each 100 pounds body weight. That is to say, a 1000-pound cow will require daily .7 pound protein and 7.2 pounds carbohydrate and fat. The following table shows approximately the amount of digestible nutrients required to maintain a *1000*-pound animal *producing different amounts of milk.* For a cow weighing more than 1000 pounds,

sufficient feed must be added to supply .07 pound protein and .72 pound carbohydrate and fat for every 100 pounds the animal weighs above the 1000 pounds.

TABLE II. Digestible Nutrients Required per Day by a 1000-pound Cow giving Different Amounts of Milk.

	Pounds		Nutritive Ratio
	Protein	Carbohydrate and Fat	
10 lbs. Milk testing 3 percent fat	1.23	9.35	1 to 7.6
20 lbs. Milk testing 3 percent fat	1.61	11.45	1 to 7.1
30 lbs. Milk testing 3 percent fat	2.03	13.58	1 to 6.7
40 lbs. Milk testing 3 percent fat	2.43	15.58	1 to 6.4
50 lbs. Milk testing 3 percent fat	2 88	17.80	1 to 6.1
60 lbs. Milk testing 3 percent fat	3.28	19.93	1 to 6.0
10 lbs. Milk testing 4 percent fat	1.25	9.74	1 to 7.8
20 lbs. Milk testing 4 percent fat	1.77	12 26	1 to 6.9
30 lbs. Milk testing 4 percent fat	2.30	14.78	1 to 6.5
40 lbs. Milk testing 4 percent fat	2.80	17.31	1 to 6 2
50 lbs. Milk testing 4 percent fat	3.33	19.82	1 to 6.0
60 lbs. Milk testing 4 percent fat	3.80	22.37	1 to 5.8
10 lbs. Milk testing 5 percent fat	1.33	10.16	1 to 7 6
20 lbs. Milk terting 5 percent fat	2.00	13.08	1 to 6.8
30 lbs. Milk testing 5 percent fat	2.55	16.31	1 to 6.4
40 lbs. Milk testing 5 percent fat	3.10	18.93	1 to 6.1
50 lbs. Milk testing 5 percent fat	3.70	21.87	1 to 5.9
60 lbs. Milk testing 5 percent fat	4.32	24.81	1 to 5.7

The amounts of nutrients for any amount of milk between those given above can be estimated.

As previously stated, it has been the custom in this work to consider three groups of nutrients: protein, carbohydrate and fat. *Since carbohydrate and fat answer the same purpose and neither is seriously lacking in our common feeds, they will be considered together here, leaving only two groups, protein and carbohydrate plus fat.* The point in balancing a ration is to get just the right amount of protein to go with the carbhhydrate and fat. This relationship is called the nutritive ratio, or the ratio of protein to carbohydrate and fat.

To make up a balanced ration proceed as follows: Suppose the cow weighs 1200 pounds and gives 30 pounds of milk, testing 4 percent butter fat. Table 2 shows that a 1000-pound cow giving that amount of milk requires 2.3 pounds of protein and 14.78 pounds of carbohydrate and fat. But she weighs 200 pounds more than the 1000 pounds; therefore, to the above should be added .14 pound of protein and 1.44 pounds of carbohydrate and fat, which gives 2.44 pounds protein and 16.22 pounds of carbohydrate and fat.

Suppose a ration is to be made from clover hay, ground corn and wheat bran. If no other roughage is fed, a 1000-pound cow will consume about 20 pounds of clover hay daily. The table of digestible nutrients on page 208 shows that 20 pounds of clover hay contains

1.24 pounds protein and 7.88 pounds of carbohydrate and fat. Add to this 8 pounds of ground corn. The table shows that it contains .624 pound protein and 6.120 pounds carbohydrate and fat. Bringing these together gives the following:

	Protein	Carbohydrate and Fat
Required amount	Pounds 2.44	Pounds 16.22
20 pounds clover hay (Mammoth)	1.240	7.880
8 pounds ground corn	.624	6.120
Total	1.864	14.000

This does not give sufficient nutrients and if more ground corn should be added, the result would be too much carbohydrate and fat, or not enough protein. Bran contains more protein and less carbohydrate and fat than corn; therefore 5 pounds of bran should be added. This gives the following:

	Protein	Carbohydrate and Fat
Required amount	Pounds 2.44	Pounds 16.22
20 pounds clover hay (Mammoth)	1.240	7.880
8 pounds of ground corn	.624	6.120
5 pounds wheat bran	.595	2.380
Total	2.459	16.380

This ration contains one pound of protein to 6.4 pounds of carbohydrate and fat, which is about the right proportion for cows giving this amount of milk. The same ration can be adjusted to other cows giving the same grade of milk by feeding one pound of grain for every 2½ pounds of milk produced

If the rule of feeding grain according to milk flow were followed strictly, a dry cow would receive no grain. This should not usually be the case, because she should be producing a calf and should be fed as if producing 10 pounds of average milk daily. The calf grows very rapidly during the last two or three months; therefore, she should be fed more than is required for maintenance. The dry period is also the time to build up the cow for the next year's work.

In making up rations it is desirable to use as much roughage as possible, because it is usually the farmers' cheapest feed. However, the capacity of the animal is limited, and we must be guided by common sense. It is possible to balance a ration in protein, carbohydrate and fat with only coarse dry roughage which the cow would

not be able to consume in large enough quantities to produce a reasonable amount of milk. It is easy to balance a ration of grain alone which is also undesirable. The ration should be balanced in amount of roughage and grain as well as in protein and carbohydrate and fat. In practical feeding, the amount of grain by weight should rarely equal the amount of dry roughage, and should usually be less than one-half as much. The proportion of grain should be varied according to the quality of the roughage and the quantity and quality of the milk produced. Where records of butter fat are kept, one pound of grain can be fed daily for each pound of fat produced per week.

RATIONS FOR A HERD

In making up a ration for a herd which averages 1000 pounds live weight, and 35 pounds of milk testing 4 percent fat, the method is the same as that used in the previous ration.

	Protein	Carbohydrate and Fat
	Pounds	Pounds
Nutrients required	2.60	16.0
18 lbs. clover hay	1.278	7.542
36 lbs. corn silage	.324	4.608
3 lbs. corn and cob meal	.132	1.995
2 lbs. ground oats	.214	1.176
2 lbs. linseed meal, O. P.	.604	.948
Total	2.552	16.269

This ration can be fed to a herd as follows: 36 pounds of silage, all the clover hay they will consume and one pound of the grain for every four or five pounds of milk produced. This ration shows a small amount of grain per pound of milk produced, but the silage contains grain. If desired, the amount of hay could be decreased and the silage and linseed meal increased or bran added.

By following this method and keeping in mind what has been said about the roughage, or bulk of the ration, and the effect of the feeds on the animal, it is easy to make up balanced rations. Dairymen cannot afford to feed a separate grain mixture to each cow; but must make up a combination of grains for the entire herd, and vary the amount to individual cows according to their production. The careful feeder will find that it will pay to study the above method and be able to make up his own combinations of feeds.

The following rations should give good results but may not be the most economical, because of the variation in the price of feeds from time to time. In these rations it is not intended that each cow

shall receive the exact number of pounds of grain mentioned, but that the grains shall be mixed in these proportions. Where alfalfa hay, or cowpea hay, or good silage is fed, the grains should be fed at the rate of about one pound of grain daily for each four to five pounds of milk produced. When such roughages as timothy, stover and clover are given, much more grain should be fed. The richer the milk, the more grain should be fed per pound of milk produced. The amount given below each ration is about an average. Where records of milk and butterfat are kept, one pound of grain can be fed daily for each pound of fat produced per week.

RATIONS SUFFICIENT FOR A 1000-POUND COW

These rations can be changed readily by making substitutions according to the directions given on page 201.

No. 1.

Roughage—Alfalfa hay at will.
Corn silage 35 to 40 pounds.
Grain—Ground corn or corn and cob meal; feed one pound per day for each 4 pounds of milk produced. For very heavy milkers, add a little bran. For very light milkers, the hay can be reduced.

No. 2.

Roughage—Alfalfa hay 10 pounds.
Corn stover at will.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 5 pounds. Wheat bran 5 pounds. Linseed meal 1½ pounds.
Feed one pound of grain to 3 to 4 pounds of milk daily.

No. 3.

Roughage—Alfalfa hay 10 pounds.
Clover hay at will.
Corn silage 30 to 40 pounds.
Grain mixture { Corn and cob meal 5 pounds. Wheat bran 3 pounds. Cotton-seed meal ½ pound.
Feed one pound of grain to 4 pounds of milk daily.

No. 4.

Roughage—Clover hay at will.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 5 pounds. Ground oats 5 pounds. Cotton-seed meal 1½ pounds.
Feed one pound of grain to 3 to 4 pounds milk daily.

No. 5.

Roughage—Clover hay 10 pounds.
Corn stover at will.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 5 pounds. Wheat bran 4 pounds. Gluten feed 3 pounds. Cotton-seed meal 1 pound.
Feed one pound grain to 4 pounds milk daily.

No. 6.

Roughage—Cowpea hay at will.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 1 pound.
Ground oats 1 pound.
Feed one pound of grain to 4½ pounds milk daily. For very heavy milkers add a little bran or oil meal. For very light milkers reduce amount of hay or oats.

No. 7.

Roughage—Cowpea hay 10 pounds.
Clover hay 10 pounds.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 5 pounds.
Ground oats 4 pounds.
Linseed meal 1 pound.
Feed one pound grain to 4 pounds milk daily.

No. 8.

Roughage—Clover hay 10 pounds.
Corn stover at will.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 5 pounds.
Wheat bran 5 pounds.
Cotton-seed meal 1½ pounds.
Gluten feed 3 pounds.
Feed one pound of grain to 3½ pounds milk daily.

No. 9.

Roughage—Corn stover 10 pounds.
Millet hay at will.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 2 pounds.
Ground oats 2 pounds.
Wheat bran 2 pounds.
Cotton seed meal 1 pound.
Feed one pound of the grain to 3 pounds of milk daily.

No. 10.

Roughage—Oat hay at will.
Corn silage 30 to 40 pounds.
Grain mixture { Ground corn 4 pounds.
Wheat bran 4 pounds.
Cotton-seed meal 1 pound.
Gluten feed 3 pounds.
Feed one pound grain to 3 pounds of milk daily.

No. 11.

Roughage—Timothy hay 10 pounds.
Corn stover at will.
Grain mixture { Ground corn 4 pounds.
Wheat bran 5 pounds.
Cotton-seed meal 2 pounds.
Feed one pound grain to 3 pounds milk daily.

No. 12.

Roughage—Sorghum hay 10 pounds.
Corn stover or timothy hay at will.
Grain mixture { Ground corn 4 pounds.
Brewers' grains 3 pounds.
Linseed meal 3 pounds.
Feed one pound grain to 3 pounds milk daily.

No. 13.

Roughage—Alfalfa hay 10 pounds.
Stover, timothy hay, or millet at will.
Grain mixture { Corn meal 1 pound.
Wheat bran 1 pound.
Feed one pound of grain to 3 pounds of milk daily.

No. 14.

Roughage—Cowpea hay or Soybean hay 15 pounds.
Corn stover or Sorghum at will.
Grain mixture { Ground corn 5 pounds.
Wheat shorts 4 pounds.
Feed one pound of grain to 3 pounds milk daily.

The following feeds are interchangeable in the above rations:

1. Alfalfa, cowpea, 1½ times as much clover.

2. Millet, Hungarian, oat hay, redtop, sorghum, corn stover, timothy, etc.

3. Silage, beets, mangels, wet beet pulp.

4. Ground corn may be replaced by corn and cob meal, hominy feeed, oats, barley, wheat, emmer, rye, or Kaffiir corn.

Other grains may be substited according to the following table, the amounts in the same column being practically equivalent for balancing purposes. For example, in any grain mixture 1 pound of cotton-seed meal can be replaced by 2.6 pounds of gluten feed without materially affecting the balance.

Cotton-seed meal..	.5	.6	.7	.9	1.0	1.1	1.2	1.3	1.4	1.6	1.7	1.8	1.9
Linseed meal N. P.	.6	.8	.9	1.0	1.2	1.3	1.5	1.6	1.8	2.0	2.1	2.2	2.4
Linseed meal O. P.	.7	.8	1.0	1 2	1.3	1.5	1.6	1.8	2.0	2.1	2.3	2.4	2.6
Soybean meal.....	.7	.8	1.0	1.2	1.4	1.6	1.7	1.9	2.1	2.2	2.4	2.6	2.7
Gluten meal.....	.8	.9	1.1	1.3	1.6	1.8	2.0	2.1	2.3	2.5	2.7	2.9	3.1
Brewers' grain, dry	1.2	1.5	1.8	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.1	4.4	4.7
Gluten feed.....	1 3	1.6	1.9	2.2	2.6	2.9	3.2	3.6	3.9	4 2	4.6	4.9	5.2
Field pea meal. ..	1 3	1.6	1 9	2.2	2.6	2.9	3.2	3.6	3.9	4.2	4.6	4.9	5.2
Cowpea meal.....	2.1	2.5	3.1	3.6	4.1	4.6	5.1	5.6	6.1	6.6	7.2	7.7	8.2
White middlings..	2 3	3 0	3.5	4.0	4.6	5.2	5.8	6.3	7.0	7.5	8.1	8.6	9.2
Germ oil meal.....	2.8	3.5	4.2	5.0	5.6	6.3	7.0	7.6	8.9	8.6	9.2	10.4	11.2
Wheat bran.....	3.8	4.6	5.5	6.3	7.6	8.3	9.2	10.1	11.1	12.0	12.9	13.9	14.8
Wheat shorts.....	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.8

In practice, it requires extra work to weigh the feed to each cow and this is not necessary. The feeds should be kept in the proper proportions (balanced) and each cow given all she will clean up well. There is a great difference in the capacity of cows of the same weight in both consumption and production, and they should be fed according to capacity. It does not pay to crowd cows too hard for a long period of time, nor does it pay to feed too sparingly. There is a point at which the increase in the milk ceases to pay for the increase in fee ' (forced feeding); this varies with different cows. Where the best results are to be obtained, the characteristics of each individual cow should be studied.

SOILING

By the term soiling we mean the cutting and feeding of green crops. When cattle are kept in the barn or in lots the entire summer and supplied green feed, it is called complete soiling; when kept on pasture and supplied green feed during the shortage of pasture, it is called partial soiling. Little complete soiling is practiced at the present time, but the use of soiling crops is increasing and will continue to increase as the price of land advances.

Advantages—It has been shown that from two to five times as many cows can be kept on the same amount of land by this system. The animals can be kept in better form because of a regular supply of feed. There is less injury to the land by tramping than if the crops were pastured. The manure can be saved and applied where wanted.

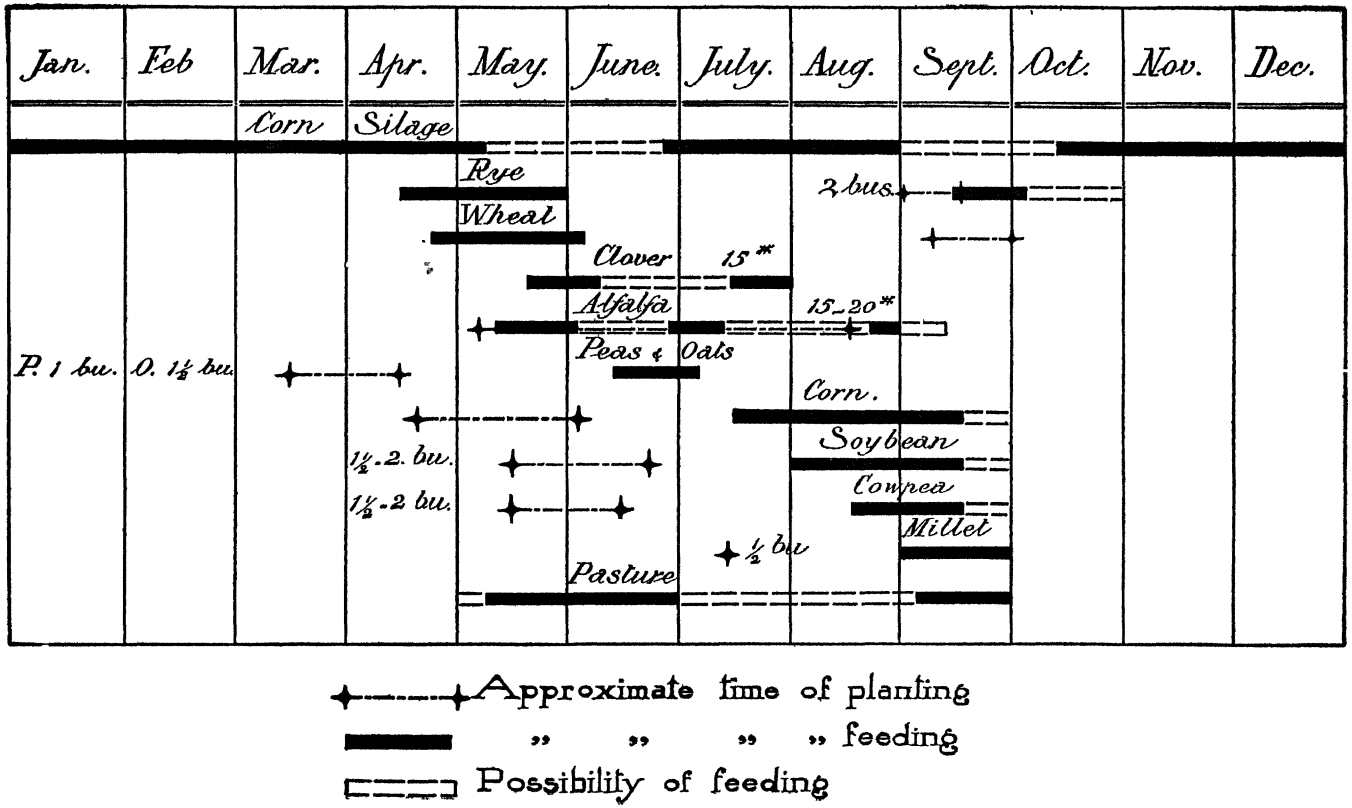
Disadvantages—More labor is required to gather the crops and care for the cattle. It requires more careful attention on the part of the herdsman. A succession of crops is not always easily arranged.

Chart I shows the more common crops used for this purpose and the approximate time of planting and feeding. The time of planting and feeding will vary in different parts of the state and with different seasons.

Corn is our most important soiling crop. It yields a large tonnage per acre, can be fed the year round in the form of silage, is easily handled and is always relished by cattle. To get the earliest feeding, early varieties should be planted as soon as the ground can be gotten into condition and the danger of frost has passed. It should be planted a little thicker than for a grain crop. For late feeding, it can be sown quite thick. If planted in the ordinary way, it will be ready to use as soon as well tasseled but is decidedly better when the ears are well formed. It takes from 60 to 80 days for it to develop far enough for use. It can be had about the middle of July, tho it should be ready much earlier in the southern than the northern part of the state. From this time it can be fed until frost. The most convenient way for dairymen who have silos would be to feed it the year round as silage, tho it is probably well for the cow to have some fresh green feed for the greater part of the summer. After the first few days, green corn can be fed very liberally.

Sorghum is not shown in the chart, but can be used much the same as corn. It yields well and is relished by the cattle but can not be secured as early as corn. It should be fed with care be ause of the danger mentioned on page 189.

CHART I. Showing seed per acre, approximate time of planting, and feeding different soiling crops.



Rye will furnish the earliest green feed, because it can be pastured and is usually ready as soon as the ground is dry enough for the cattle to go upon it. It can be used from this time continuously until it gets fairly well matured, when the cows will not consume large quantities of it. It is also possible to get some fall pasture if sown early. Wheat can be used in place of rye.

Oats makes an excellent soiling crop and can be made to follow the rye in feeding period. It should be sown as early as the ground can be gotten into shape. One sowing will be in good condition for feeding for about ten days. If three sowings are made ten days apart, the feeding can be extended over a period of twenty to twenty-five days. If more is sown than is needed, it can be made into hay of good quality. If the Canada field pea is sown with the oats, it makes a more nearly balanced ration.

The **clovers** can be used to good advantage for soiling and are especially valuable to feed with the above crops. Medium red clover can be depended upon for but a short time at two cuttings. After it is large enough to cut to good advantage it soon gets beyond the best feeding stage and cattle will not consume large enough quantities. The first cutting can be followed by mammoth clover, which comes on more slowly. Alsike can be used, but does not yield as well as the other clovers.

Alfalfa is an excellent crop for soiling purposes. Theoretically, it could be used the entire season, but practically this does not work If it is cut too early, it is apt to affect seriously the succeeding crop This fact limits the time it can be fed to about one week at each cutting. It can be pastured for the entire season but this kills it out and should not be done unless it is to be plowed up the following season.

The **Cowpea** can be used to good advantage late in the summer and goes well with the corn which is available at that time, tho it is not so palatable as corn. It can be planted after a crop of peas and oats has been removed and may be had until frost. It grows better in the southern and central parts of the state than in the northern; and is ready to feed as soon as the first blossoms appear.

The **Soybean** can be had earlier than the cowpea but it is not so palatable.

There are other soiling crops but these are the most important for Ohio conditions. These feeds can be fed in the barn, in racks in the lot, or on the pasture. In feeding any of them, the condition of the cattle should be watched carefully. Some dry roughage should be kept where the cows can get it.

If the cows are to do their best, it is important that they do not lack feed during any time of the year. If the flow of milk is permitted to decrease materially it is very difficult to bring it back to the point it would have reached, had an abundance of feed been supplied. The effects of meager feeding last for some time after liberal feeding has been restored.

FEEDING GRAIN ON PASTURE

Experiments at the Kansas, Mississippi, Utah and Cornell, (New York) Stations have shown that feeding grain to cows while on good pasture does not pay directly. An increase in milk was obtained but not sufficient to pay for the grain. In some cases there was a gain on the next year's production by the cows receiving the grain. Where the pastures are short and no soiling crops are available, it will pay to feed some grain. The feeder must be guided in the amount to feed by the production of the cow and the condition of the pasture. Feed a grain mixture with a nutritive ratio of about one to six.

WATER

Cows should have access twice daily to an abundance of fresh clean water. In very cold weather it is better that a heater be used in the tank to prevent freezing and to take off the chill. Water need not be very warm, but it should not be ice cold. Individual watering devices attached to the stalls usually become unsanitary unless watched closely. Milch cows should not be permitted to drink from stagnant ponds.

SALT

Salt should be supplied at the rate of from ¾ to 1 ounce per cow daily. This should be given as often as twice per week, in any convenient way. A common salt box in the yard is objectionable unless all cows are free from disease.

CARE

Cows poorly wintered will not do as well the following year. Milch cows can not withstand as much cold as fattening steers, and should be protected from severe weather and cold rains. The cow that is kept comfortable will give the best returns.

This Table shows the amount of Digestible Nutrients in one or more pounds of the feeding stuffs named, modified from Henry's "Feeds and Feeding"

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio	Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
				GRAINS					
	Lbs.	Lbs.	Lbs.			Lbs.	Lbs.	Lbs.	
Dent corn	1	.078	.765	1:9.8	Germ oil meal	1	.158	.631	1:4.0
" "	2	.156	1.530		" " "	2	.316	1.262	
" "	3	.234	2.295		" " "	3	.474	1.893	
" "	4	.312	3.060		" " "	4	.632	2.524	
" "	5	.390	3.825		" " "	5	.790	3 155	
" "	6	.468	4.590		" " "	6	.948	3.786	
" "	7	.546	5.355		" " "	7	1.106	4.417	
" "	8	.624	6.120		" " "	8	1.264	5.048	
" "	9	.702	6.885		" " "	9	1.422	5 679	
" "	10	.780	7.650		" " "	10	1.580	6.310	
Corn meal	1	.067	.721	1:10.7	Hominy feed	1	.068	.771	1:11.3
" "	2	.134	1 442		" "	2	.136	1.542	
" "	3	.201	2.163		" "	3	.204	2.313	
" "	4	.268	2.884		" "	4	.272	3.084	
" "	5	.335	3.605		" "	5	.340	3.855	
" "	6	.402	4 326		" "	6	.408	4.626	
" "	7	.469	5.047		" "	7	.476	5.397	
" "	8	.536	5.768		" "	8	.544	6.168	
" "	9	.603	6.489		" "	9	.612	6.939	
" "	10	.670	7.210		" "	10	.680	7.710	
Corn & cob meal	1	.044	.665	1:15.1	Wheat	1	.088	.709	1:8.0
" " "	2	.088	1.330		"	2	.176	1.418	
" " "	3	.132	1.995		"	3	.264	2.127	
" " "	4	.176	2.660		"	4	.352	2.836	
" " "	5	.220	3.325		"	5	.440	3.545	
" " "	6	.264	3.990		"	6	.528	4.254	
" " "	7	.308	4.665		"	7	.616	4.963	
" " "	8	.352	5.320		"	8	.704	5.672	
" " "	9	.396	5.985		"	9	.792	6.381	
" " "	10	.440	6.650		"	10	.880	7.090	
Corn bran	1	.06	.633	1:10.5	Wheat bran	1	.119	.476	1:4.0
" "	2	.120	1.266		" "	2	.238	.952	
" "	3	.180	1.899		" "	3	.357	1.428	
" "	4	.240	2.532		" "	4	.476	1.904	
" "	5	.300	3.165		" "	5	.595	2.380	
" "	6	.360	3.798		" "	6	.714	2.856	
" "	7	.420	4.431		" "	7	.833	3.332	
" "	8	.480	5.064		" "	8	.952	3.808	
" "	9	.540	5.697		" "	9	1.071	4.284	
" "	10	.600	6.330		" "	10	1.190	4.760	
Gluten meal	1	.297	.552	1:1.9	Wheat middlings (white)	1	.169	.628	1;3;7
" "	2	.594	1.104		" "	2	.338	1.256	
" "	3	.891	1.656		" "	3	.507	1.884	
" "	4	1.188	2.208		" "	4	.976	2.512	
" "	5	1.485	2.760		" "	5	.845	3.140	
" "	6	1.782	3.312		" "	6	1.014	3.768	
" "	7	2.079	3.864		" "	7	1.183	4.396	
" "	8	2.376	4.416		" "	8	1.352	5.024	
" "	9	2.673	4.968		" "	9	1.521	5.652	
" "	10	2.970	5.520		" "	10	1.690	6.280	
Gluten feed	1	.213	.593	1:2.8	Wheat shorts	1	.130	.558	1:4.3
" "	2	.426	1.186		" "	2	.260	1.116	
" "	3	.639	1.779		" "	3	.390	1.674	
" "	4	.852	2.372		" "	4	.520	2.232	
" "	5	1.065	2.965		" "	5	.650	2.790	
" "	6	1.278	3.558		" "	6	.780	3.348	
" "	7	1.491	4.151		" "	7	.910	3.906	
" "	8	1.704	4.744		" "	8	1.040	4.464	
" "	9	1.917	5.337		" "	9	1.170	5.022	
" "	10	2.130	5.930		" "	10	1.130	5.580	

Table continued

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
	Lbs.	Lbs.	Lbs.	
Rye	1	.095	.721	1:7.6
"	2	.190	1.442	
"	3	.285	2.163	
"	4	.380	2.884	
"	5	.475	3.605	
"	6	.570	4.326	
"	7	.665	5.047	
"	8	.760	5.768	
"	9	.855	6.489	
"	10	.960	7.210	
Rye bran	1	.115	.508	1:4.4
" "	2	.230	1.016	
" "	3	345	1.524	
" "	4	.460	2 032	
" "	5	.575	2.540	
" "	6	.690	3.048	
" "	7	.805	3.556	
" "	8	.920	4.064	
" "	9	1.035	4.572	
" "	10	1.150	5 080	
Rye middlings	1	.110	.583	1:5.3
" "	2	.220	1.166	
" "	3	.330	1.749	
" "	4	.440	2.332	
" "	5	.550	2.915	
" "	6	.660	3.498	
" "	7	.770	4.081	
" "	8	.880	4.664	
" "	9	.990	5 247	
" "	10	1.100	5.830	
Barley	1	.084	.690	1:8.3
"	2	.168	1.380	
"	3	.252	2 070	
"	4	.336	2.760	
"	5	.420	3.450	
"	6	.504	4 140	
"	7	.588	4.830	
"	8	.672	5.520	
"	9	.756	6 210	
"	10	.840	6.900	
Brewer's grains (wet malt)	1	.049	.114	1:2.3
" "	10	.490	1.140	
" "	11	.539	1.254	
" "	12	.588	1.368	
" "	13	.637	1.482	
" "	14	.686	1.596	
" "	15	.735	1.710	
" "	16	.784	1.824	
" "	17	.833	1.938	
" "	18	.882	2.052	
" "	19	.931	2.166	
" "	20	.980	2.280	
Brewer's grains (dried malt)	1	.200	.457	1:2.9
" "	2	.400	.914	
" "	3	.600	1.371	
" "	4	.800	1.828	
" "	5	1.000	2.285	
" "	6	1.200	2.742	
" "	7	1.400	3.199	
" "	8	1.600	3.656	
" "	9	1.800	4.113	
" "	10	2.000	4.570	
"				

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
	Lbs.	Lbs.	Lbs.	
Distillers' grains	1	.228	.658	1:2.8
" "	2	.456	1.316	
" "	3	.684	1 974	
" "	4	.912	2.632	
" "	5	1.140	3.290	
" "	6	1.368	3.948	
" "	7	1.596	4.606	
" "	8	1.824	5.264	
" "	9	2.052	5.922	
" "	10	2.280	6.580	
Oats	1	.107	.588	1:5.5
"	2	.214	1.176	
"	3	.321	1.764	
"	4	.428	2.352	
"	5	.535	2.940	
"	6	.642	3.528	
"	7	.749	4 116	
"	8	.856	4.704	
"	9	.963	5.292	
"	10	1.070	5.880	
"				
Old process linseed meal, oil meal or cake	½	.151	.237	1:1.6
" "	1	.302	.475	
" "	1-½	.453	.713	
" "	2	.604	.950	
" "	2-½	.755	1.188	
" "	3	.906	1.425	
" "	3-½	1.057	1.662	
" "	4	1.208	1.900	
" "	4-½	1.359	2.138	
" "	5	1.510	2.375	
New process linseed meal, oil meal or cake	½	.157	.205	1:1.3
" "	1	.315	.411	
" "	1-½	.473	.616	
" "	2	630	.822	
" "	2-½	.788	1.028	
" "	3	.945	1.233	
" "	3-½	1.103	1.439	
" "	4	1.260	1.644	
" "	4-½	1.418	1.850	
" "	5	1.575	2.055	
Cotton-seed meal or cake	½	.188	.215	1:1.1
" "	1	.376	.430	
" "	1-½	.564	.645	
" "	2	.752	.860	
" "	2-½	.940	1.075	
" "	3	1.128	1.290	
" "	3-½	1.316	1.505	
" "	4	1 504	1.720	
" "	4-½	1.692	1.935	
" "	5	1.880	2.150	
Field peas	½	099	.251	1:2.5
" "	1	.197	.502	
" "	1-½	.296	.753	
" "	2	.394	1.006	
" "	2-½	.493	1.255	
" "	3	.591	1.506	
" "	3-½	.690	1.757	
" "	4	.788	2.008	
" "	4-½	.887	2.259	
" "	5	.985	2.510	

Table continued

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio	Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
	Lbs.	Lbs.	Lbs.			Lbs.	Lbs.	Lbs.	
Soybean	½	.146	.281	1:1.9	Beet pulp	1	.041	649	1:15.8
"	1	.291	.561		" "	2	.082	1.298	
"	1-½	.437	.812		" "	3	.123	1.947	
"	2	.582	1.122		" "	4	.164	2 596	
"	2-½	.728	1.403		" "	5	.205	3.245	
"	3	.873	1.683		" "	6	.246	3.894	
"	3-½	1.019	1.964		" "	7	.287	4.543	
"	4	1.164	2.244		" "	8	.328	5.192	
"	4-½	1.310	2.525		" "	9	.369	5.841	
"	5	1.455	2.805		" "	10	.410	6.490	
					DRY ROUGHAGE				
Fodder corn field cured	1	.025	.373	1:14.9	Alsike clover hay	1	.084	.422	1:5.0
" "	2	.050	.746		" "	2	.168	.844	
" "	4	.100	1.492		" "	4	.336	1.688	
" "	6	.150	2.238		" "	6	.504	2.532	
" "	8	.200	2.984		" "	8	.672	3.376	
" "	10	.250	3.730		" "	10	.840	4.220	
" "	12	.300	4.476		" "	12	1.008	5.064	
" "	14	.350	5.222		" "	14	1.176	5.908	
" "	16	.400	5.968		" "	16	1.344	6.752	
" "	18	.450	6.714		" "	18	1.512	7.596	
" "	20	.500	7.460		" "	20	1.680	8.440	
Corn stover field cured (stalks)	1	.014	.327	1:2.3	Crimson clover hay	1	.105	.376	1:3.5
" "	2	.028	.654		" "	2	.210	.752	
" "	4	.056	1.308		" "	4	.420	1.504	
" "	6	.084	1.962		" "	6	.630	2.256	
" "	8	.112	2.616		" "	8	.840	3.008	
" "	10	.140	3.270		" "	10	1.050	3.760	
" "	12	.168	3.924		" "	12	1.260	4.512	
" "	14	.196	4.578		" "	14	1.470	5.264	
" "	16	.224	5.232		" "	16	1.680	6.016	
" "	18	.252	5.886		" "	18	1.890	6.768	
" "	20	.280	6.540		" "	20	2.100	7.520	
Red clover hay, medium	1	.071	.419	1:5.9	Alfalfa hay	1	.111	.405	1:3.6
" "	2	.142	.838		" "	2	.222	.810	
" "	4	.284	1.676		" "	4	.444	1.620	
" "	6	.426	2.514		" "	6	.666	2.430	
" "	8	.568	3.352		" "	8	.888	3.240	
" "	10	.710	4.190		" "	10	1.110	4.050	
" "	12	.852	5.028		" "	12	1.332	4.860	
" "	14	.994	5.866		" "	14	1.554	5.670	
" "	16	1.136	6.704		" "	16	1.776	6.480	
" "	18	1.278	7.542		" "	18	1.998	7.290	
" "	20	1.420	8.380		" "	20	2.220	8.100	
Red clover hay, mammoth	1	.062	.394	1:6.3	Cowpea hay	1	.100	.422	1:4.2
" "	2	.124	.788		" "	2	.200	.844	
" "	4	.248	1.576		" "	4	.400	1.688	
" "	6	.372	2.364		" "	6	.600	2.532	
" "	8	.496	3.152		" "	8	.800	3.376	
" "	10	.620	3.940		" "	10	1.000	4.220	
" "	12	.744	4.728		" "	12	1.200	5.064	
" "	14	.868	5.516		" "	14	1.400	5.908	
" "	16	.992	6 304		" "	16	1.600	6.752	
" "	18	1.116	7.092		" "	18	1.800	7.596	
" "	20	1.240	7.880		" "	20	2.000	8.440	

Table continued

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
	Lbs.	Lbs.	Lbs.	
Soybean hay	1	.106	.436	1:4.1
" "	2	.212	.872	
" "	3	.318	1 308	
" "	4	.424	1.744	
" "	5	.530	2.180	
" "	6	.636	2.616	
" "	7	.742	3 052	
" "	8	.848	3.488	
" "	9	.954	3.924	
" "	10	1.060	4.360	
Pea-vine straw	1	.043	.341	1:7.9
" " "	2	.086	682	
" " "	3	.129	1.023	
" " "	4	.172	1.364	
" " "	5	.215	1.705	
" " "	6	.258	2.046	
" " "	7	.301	2.387	
" " "	8	.344	2.728	
" " "	9	.387	3.069	
" " "	10	.430	3.410	
Timothy hay	1	.028	.453	1:16.1
"	2	.056	.906	
"	3	.084	1.359	
"	4	.112	1.812	
"	5	.140	2.265	
"	6	.168	2.718	
"	7	.196	3.171	
"	8	.224	3 624	
"	9	.252	4.077	
"	10	.280	4.530	
Orchard grass hay	1	.049	.455	1:9.2
" "	2	.098	.910	
" "	3	.147	1.365	
" "	4	.196	1 820	
" "	5	.245	2.275	
" "	6	.294	2 730	
" "	7	.343	3.185	
" "	8	.392	3 640	
" "	9	.441	4.095	
" "	10	.490	4.550	
Redtop hay	1	.048	.491	1:10.2
" "	2	.096	.982	
" "	3	.144	1.473	
" "	4	.192	1.964	
" "	5	.240	2.455	
" "	6	.288	2.946	
" "	7	.336	3.437	
" "	8	.384	3.928	
" "	9	.432	4.419	
" "	10	.480	4.910	
"				
Millet hay	1	.052	.404	1:7.7
" "	2	.104	.808	
" "	3	.156	1.212	
" "	4	.208	1.616	
" "	5	.260	2.020	
" "	6	.312	2.424	
" "	7	.364	2.828	
" "	8	.416	3.232	
" "	9	.468	3.636	
" "	10	.520	4.040	

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
	Lbs.	Lbs.	Lbs.	
Hungarian hay	1	.050	.495	1:9.9
" "	2	.100	.990	
" "	3	.150	1.485	
" "	4	.200	1.980	
" "	5	.250	2.475	
" "	6	.300	2.970	
" "	7	.350	3.465	
" "	8	.400	3.960	
" "	9	.450	4.455	
" "	10	5.00	4.950	
Oat hay	1	.047	.405	1:8.6
" "	2	.094	.810	
" "	3	.141	1 215	
" "	4	.188	1.620	
" "	5	.235	2.025	
" "	6	.282	2.430	
" "	7	.329	2.835	
" "	8	.376	3.240	
" "	9	.423	3.645	
" "	10	.470	4.050	
Wheat straw	1	.008	.361	1:45
" "	2	.016	.722	
" "	3	.024	1 083	
" "	4	.032	1.444	
" "	5	.040	1.805	
" "	6	.048	2.166	
" "	7	.056	2.527	
" "	8	.064	2.888	
" "	9	.072	3.249	
" "	10	.080	3.610	
Rye straw	1	.007	.405	1:57.8
" "	2	.014	.810	
" "	3	.021	1.215	
" "	4	.028	1.620	
" "	5	.035	2.025	
" "	6	.042	2.430	
" "	7	.049	2.835	
" "	8	.056	3.240	
" "	9	.063	3.645	
" "	10	.070	4.050	
Oat straw	1	.013	.413	1:31.7
" "	2	.026	.826	
" "	3	.039	1.239	
" "	4	.052	1.652	
" "	5	.065	2.065	
" "	6	.078	2.478	
" "	7	.091	2.891	
" "	8	.104	3.304	
" "	9	.117	3.757	
" "	10	.130	4.130	

Table continued

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
		GREEN ROUGHAGE		
	Lbs.	Lbs.	Lbs.	
Fodder corn, green stalks & ears	1	.010	.128	1:12.8
" "	10	.100	1.280	
" "	11	.110	1.408	
" "	12	.120	1.536	
" "	13	.130	1.664	
" "	14	.140	1.792	
" "	15	.150	1.920	
" "	16	.160	2.048	
" "	17	.170	2.176	
" "	18	.180	2.304	
" "	19	.190	2 432	
" "	20	.200	2.560	
Red clover, different stages	1	.029	.165	1:5.6
" "	10	.290	1.650	
" "	11	.319	1.825	
" "	12	.345	1.980	
" "	13	.377	2.145	
" "	14	.406	2.310	
" "	15	.435	2.475	
" "	16	.464	2 640	
" "	17	.493	2.805	
" "	18	.522	2.970	
" "	19	.551	3.135	
" "	20	.580	3.300	
Alsike in bloom	1	.026	.125	1:4.8
"	10	.260	1.250	
"	11	.286	1.375	
"	12	.312	1.500	
"	13	.338	1.625	
"	14	.364	1.750	
"	15	.390	1.875	
"	16	.416	2 000	
"	17	.442	2.125	
"	18	.468	2.250	
"	19	.494	2.375	
"	20	.520	2.500	
Crimson clover	1	.024	.122	1:4.2
" "	10	240	1.102	
" "	11	.264	1.020	
" "	12	.288	1.224	
" "	13	.312	1.326	
" "	14	.336	1.428	
" "	15	.360	1.530	
" "	16	.384	1.632	
" "	17	.408	1.734	
" "	18	.432	1.836	
" "	19	.456	1 938	
" "	20	.480	2.040	
Alfalfa	1	.036	.130	1:3.6
"	10	.360	1.300	
"	11	.396	1 430	
"	12	.432	1.560	
"	13	.468	1.690	
"	14	.504	1.820	
"	15	540	1.950	
"	16	.576	2.080	
"	17	.612	2.210	
"	18	.648	2.340	
"	19	.684	2.470	
"	20	.720	2.600	
Cowpea	1	.018	.092	1:5.1
"	10	.180	.920	
"	11	.198	1.012	
"	12	.216	1.104	
"	13	.234	1.196	
"	14	.252	1.288	
"	15	.270	1.380	
"	16	.288	1.472	
"	17	.306	1.564	
"	18	.324	1.656	
"	19	.342	1.748	
"	20	.360	1.840	
Soybean	1	.031	.121	1:3.9
"	10	.310	1.210	
"	11	.341	1.331	
"	12	.372	1.452	
"	13	.403	1.573	
"	14	.434	1.694	
"	15	.465	1.815	
"	16	.496	1.936	
"	17	.527	2.057	
"	18	.558	2.178	
"	19	.589	2.299	
"	20	.620	2.420	
Green barley	1	.019	.174	1:9.1
Peas, and oats in head	1	.018	.111	1:6.1
Peas, and barley in head	1	.021	.100	1:4.8
Timothy, different stages	1	.015	.214	1;14.2
Orchard grass in bloom	1	.012	.145	1:12.1
Redtop in bloom	1	.019	.224	1:11.7
Oat in head	1	.025	.205	1:8.2
Rye in head	1	.021	.150	1:7.1
Sorghum, green	1	.006	.123	1:20.5
Hungarian grass	1	.020	.143	1:7.1
Pasture grasses mixed	1	.023	.157	1:6.8
Kentucky bluegrass	1	.028	.215	1;7.6

Table continued

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutritive ratio
CORN SILAGE				
Corn silage	Lbs. 1	Lbs. 014	Lbs. .158	1:11.3
"	14	.196	2.212	
"	16	.224	2.528	
"	18	.252	2.844	
"	20	.280	3.160	
"	22	.308	3.476	
"	24	.336	3.792	
"	26	.364	4.108	
"	28	.392	4.424	
"	30	.420	4.740	
"	32	.448	5.056	
"	34	.476	5.372	
"	36	.504	5.688	
"	38	.532	6.004	
"	40	.560	6 636	
Clover	1	.015	.103	1:6.18
"	10	.150	1.030	
"	12	.180	1.236	
"	14	.210	1.442	
"	16	.240	1.648	
"	18	.270	1.854	
"	20	.300	2.060	
"	22	.330	2.266	
"	24	.360	2.472	
"	26	.390	2.678	
"	28	.420	2.884	
"	30	.450	3.090	
Sorghum	1	.001	.140	1:14.0
"	10	010	1.400	
"	12	.012	1.680	
"	14	.014	1.960	
"	16	.016	2.240	
"	18	.018	2.520	
"	20	.020	2.800	
"	22	.022	3.080	
"	24	.024	3.360	
"	26	.026	3.640	
"	28	.028	3.920	
"	30	.030	4.200	
Sugar beet	1	.013	.100	1:7.7
" "	14	.182	1.400	
" "	16	.208	1.600	
" "	18	.234	1.800	
" "	20	.260	2.000	
" "	22	.286	2.200	
" "	24	.312	2.400	
" "	26	.338	2.600	
" "	28	.364	2.800	
" "	30	.390	3.000	
" "	32	.416	3.200	
" "	34	.442	3.400	
" "	36	.468	3.600	
" "	38	.494	3.800	
" "	40	.520	4.000	

Kind of feed		Digestible protein	Digest. Carbo. & fat	Nutrit. ive ratio
Alfalfa	Lbs. 1	Lbs. .030	Lbs. .128	1:4.2
"	10	.300	1.280	
"	12	.360	1.536	
"	14	.420	1.792	
"	16	.480	2.048	
"	18	.540	2.304	
"	20	.600	2.560	
"	22	.660	2.816	
"	24	.720	3.072	
"	26	.780	3.328	
"	28	.840	3.584	
"	30	.900	3.840	
Cowpea	1	.015	.106	1:7.0
"	10	.150	1.060	
"	12	.180	1 272	
"	14	210	1.484	
"	16	.240	1.696	
"	18	.270	1.908	
"	20	.300	2.120	
"	22	.330	2.332	
"	24	.360	2.544	
"	26	.390	2.756	
"	28	.420	2.968	
"	30	.450	3.180	
MISCELLANEOUS				
Pumpkin, field	1	.010	.063	1:6.3
Rape	1	.015	.085	1:5.6
Dried blood	1	.523	.056	1:1.7
Beet pulp, wet	1	.006	.073	1:12.1
Beet molasses	1	.091	.595	1:6.5
Cow's milk	1	.036	.132	1:3.6
Skimmilk	1	.029	.059	1:2.0
Buttermilk	1	.039	.065	1:1.6
Whey	1	.008	.054	1:6.7
ROOTS				
Mangel	1	.010	.060	1:6.0
"	14	.140	.840	
"	16	.160	.960	
"	18	.180	1.080	
"	20	.200	1.200	
"	22	.220	1.320	
"	24	.240	1.440	
"	26	.260	1.560	
"	28	.280	1.680	
"	30	.300	1.800	
"	32	.320	1.920	
"	34	.340	2.040	
"	36	.360	2.160	
"	38	.380	2.280	
"	40	.400	2.400	

The above table shows the chemical composition of our feeds in so far as it is absolutely necessary for making balanced rations. To balance a ration, combine such of the above feeds as will give the right amounts of protein, carbohydrate and fat.

This page intentionally blank.